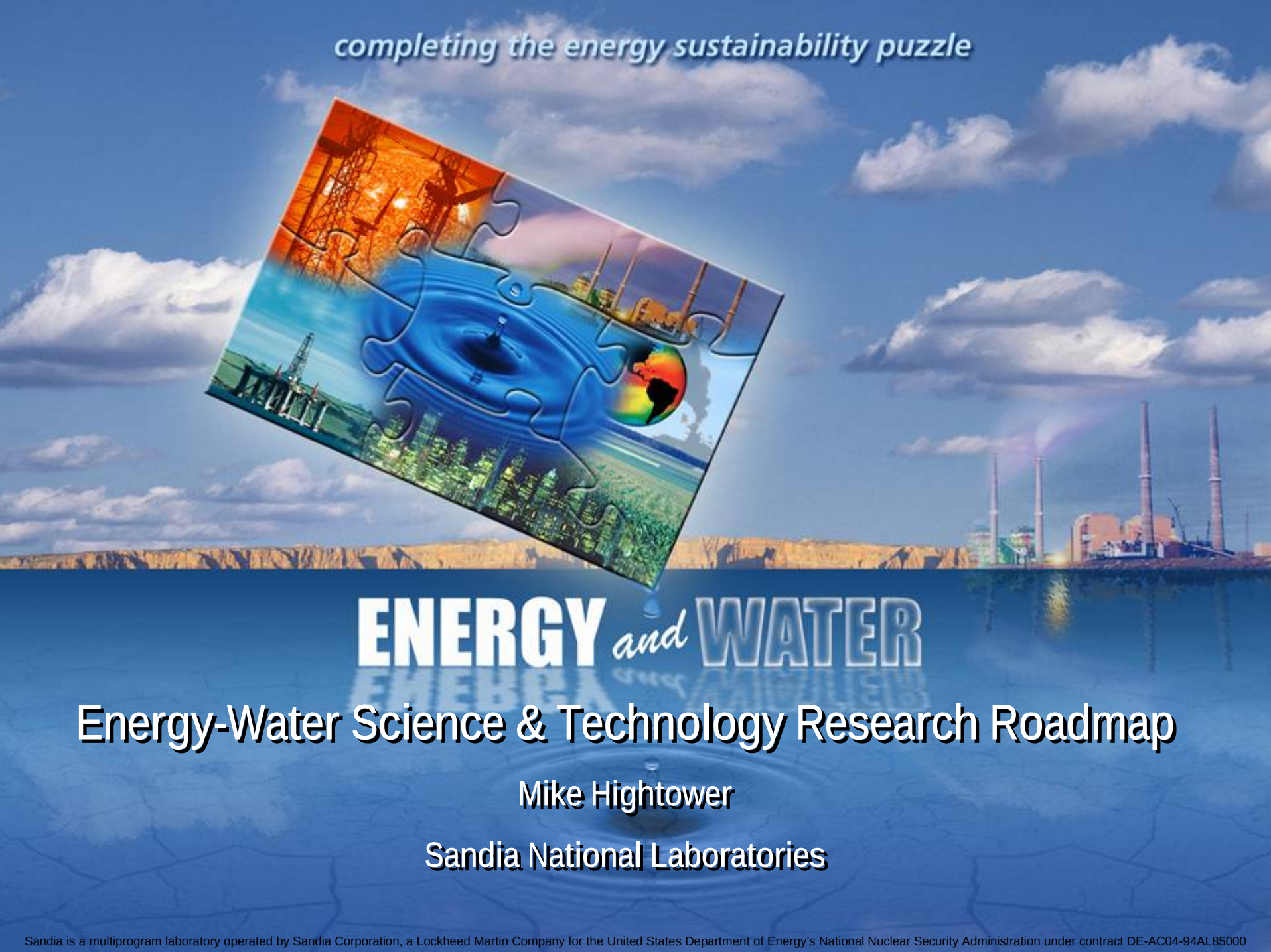


Energy-Water Science & Technology Research Roadmap

Mike Hightower

Sandia National Laboratories

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000

US Energy Sustainability

ENERGY and WATER

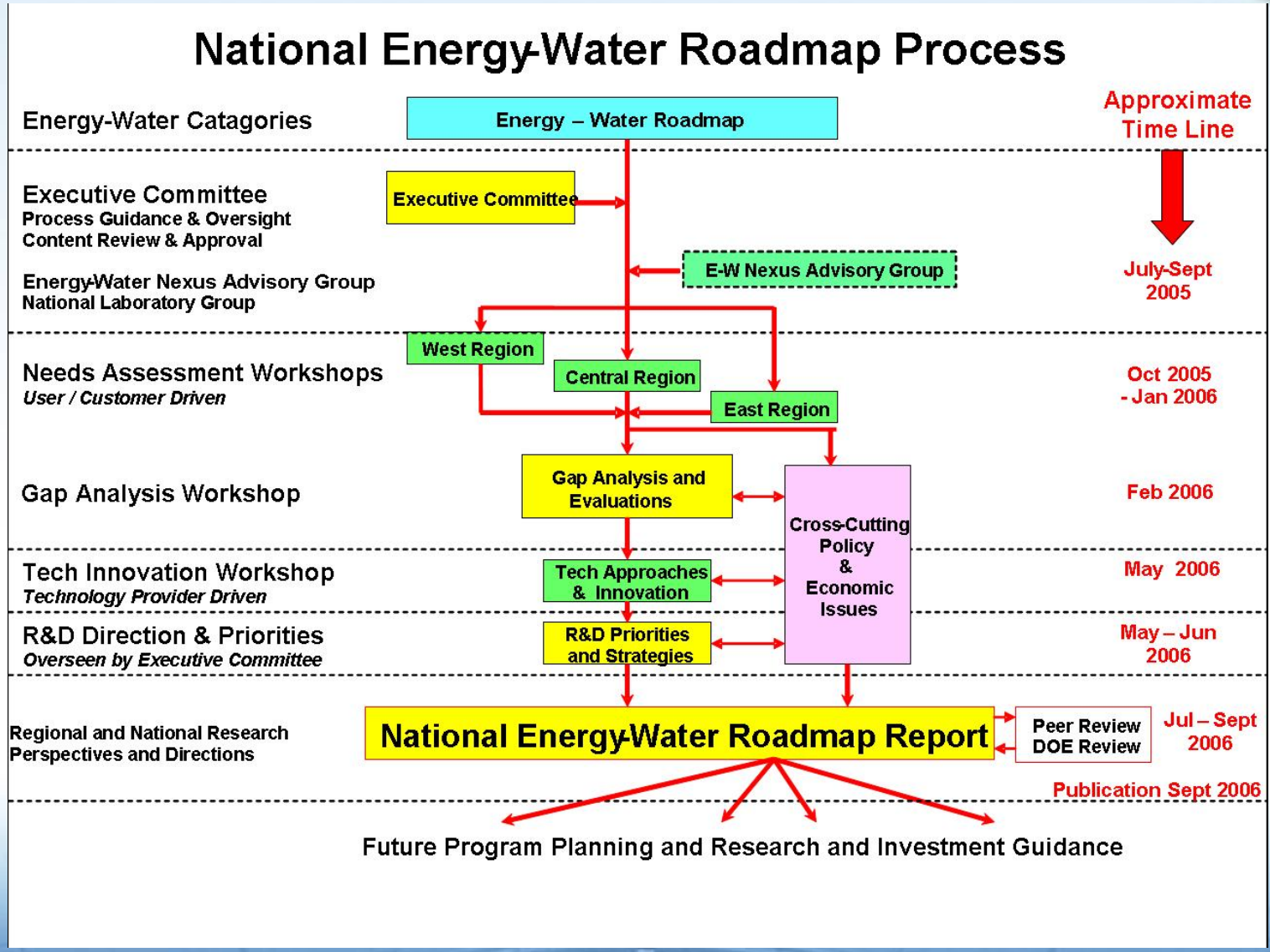
Overview

- Energy-Water Science and Technology Roadmap
  - Process, schedule, goals, participants
- Technical Workshops Summary
  - Regional and national issues and challenges identified
  - Some suggested science and technology research and development directions
- www.sandia.gov/energy-water
  - Mike Hightower, 505-844-5499, mmhight@sandia.gov

Energy-Water Roadmap

- Sandia National Laboratories
  - Coordinate roadmap efforts – workshops, gap analysis, ranking efforts, and roadmap report
  - www.sandia.gov/energy-water
- Executive Committee
  - Representatives from - energy utilities, water management groups, environmental groups, energy and water regulators, utility associations, oil and gas, natural resource experts
- National Lab Advisory team
  - Support science and technology issues analysis
- UNM Utton Transboundary Center and Lawrence Berkeley National Laboratory
  - Coordinate policy, regulatory, and economic issues analysis

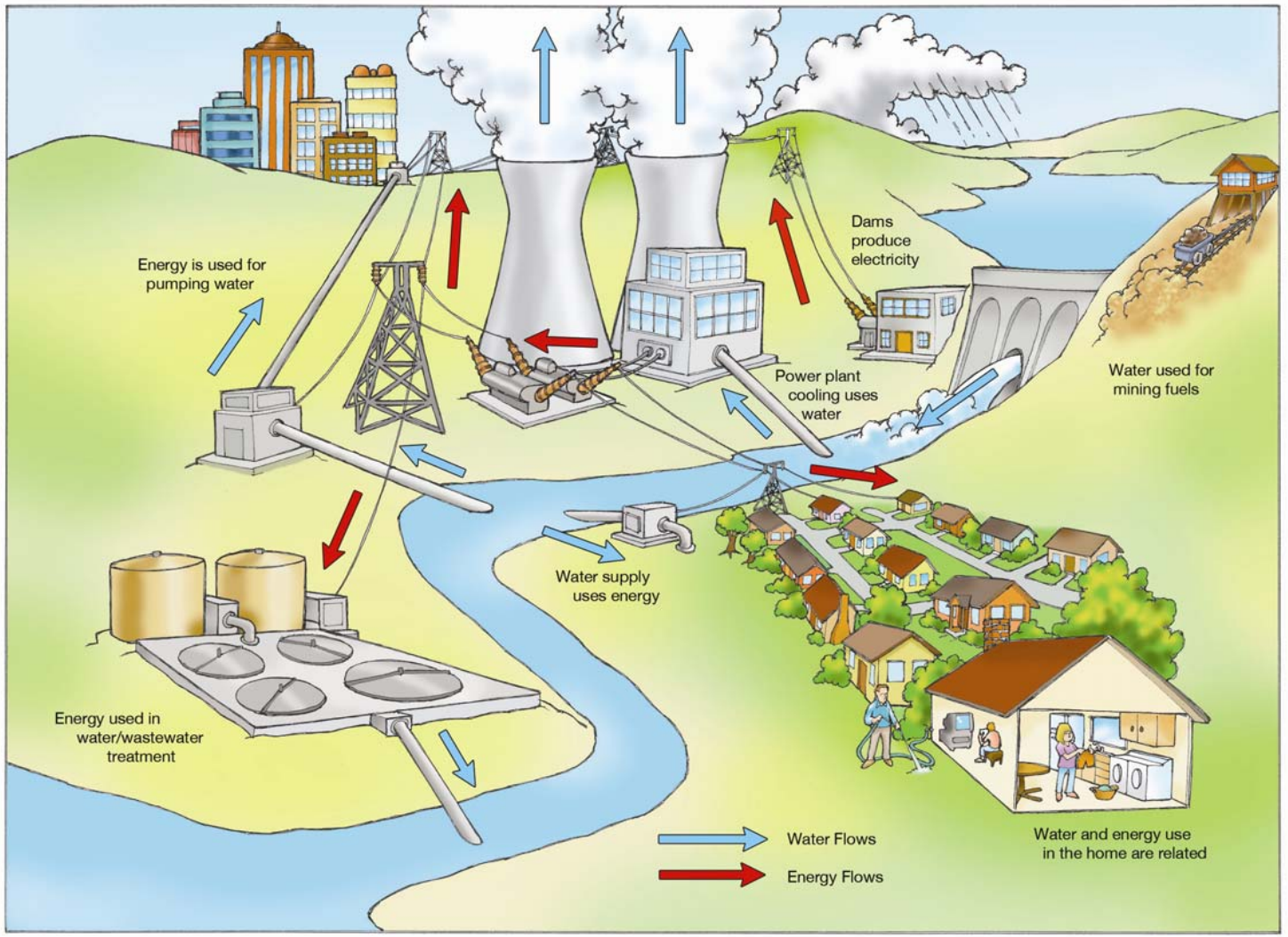
Energy-Water Roadmap Process



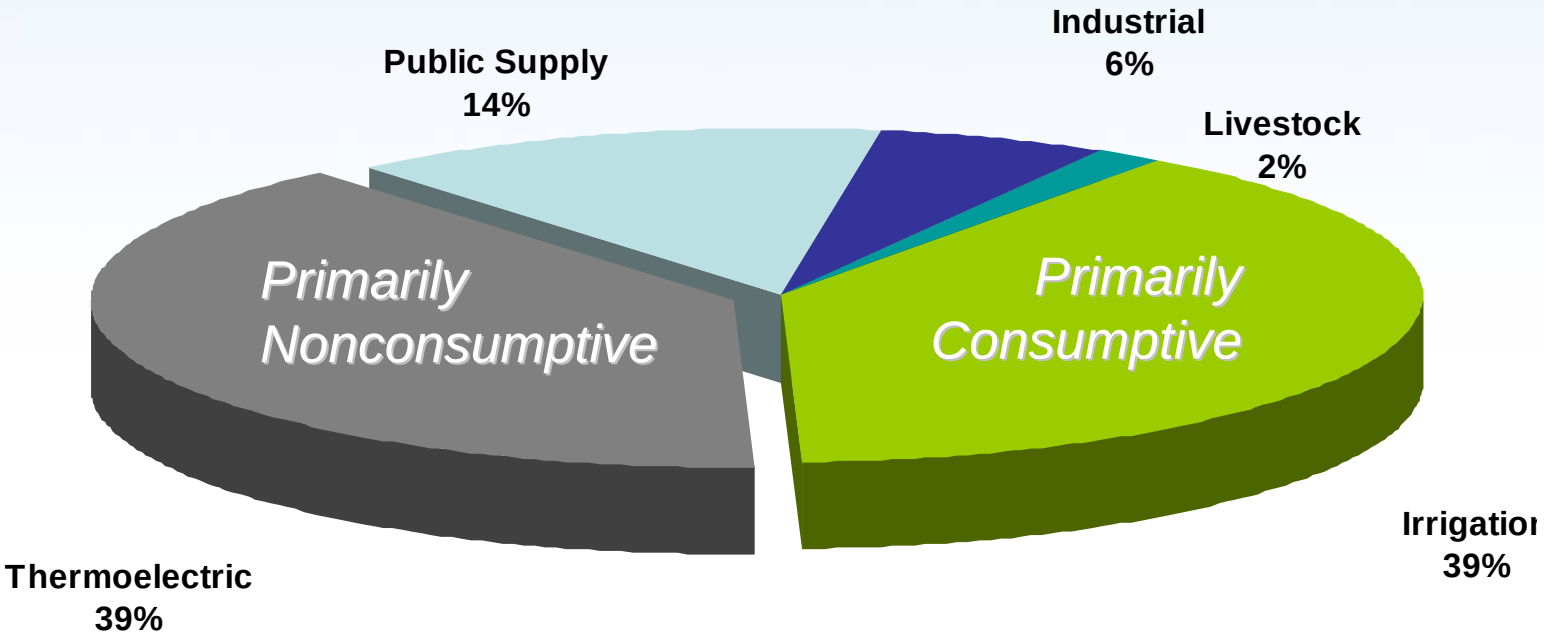
Needs Assessment Workshop Overview

- Three regional workshops: Nov 2005 through mid-January 2006
  - Kansas City, Baltimore, Salt Lake City
  - Almost 350 participants from 45 states involved overall
- Focus on emerging user and stakeholder problems, issues, and needs and science and technology role in developing effective solutions
- Broad spectrum of regional, state, and local participation and input
  - Representatives from energy companies, electric utilities, water utilities, water managers, economic development groups, energy regulators, environmental groups, tribal nations, other water-use sectors
- Captured high-level issues, needs, and recommendations identified in each workshop

Water and Energy are related commodities in our economy



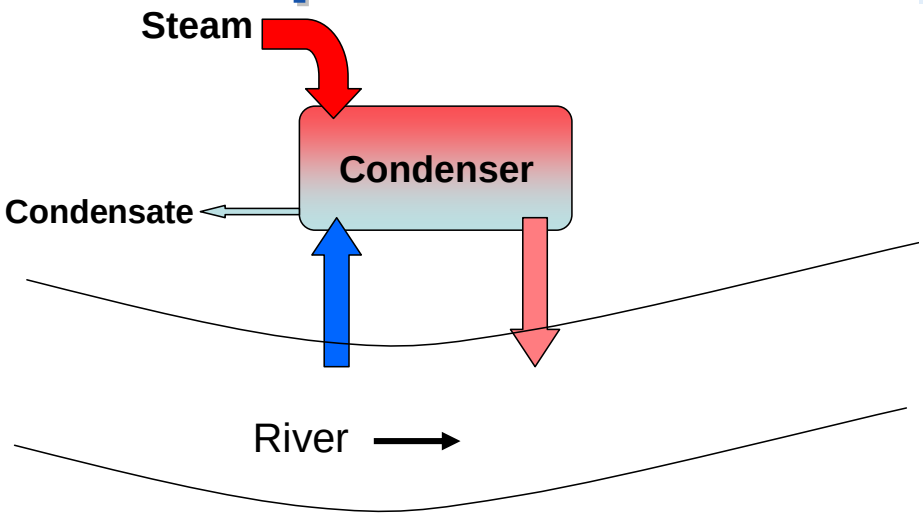
Energy and agriculture withdraw the most water in the U.S.



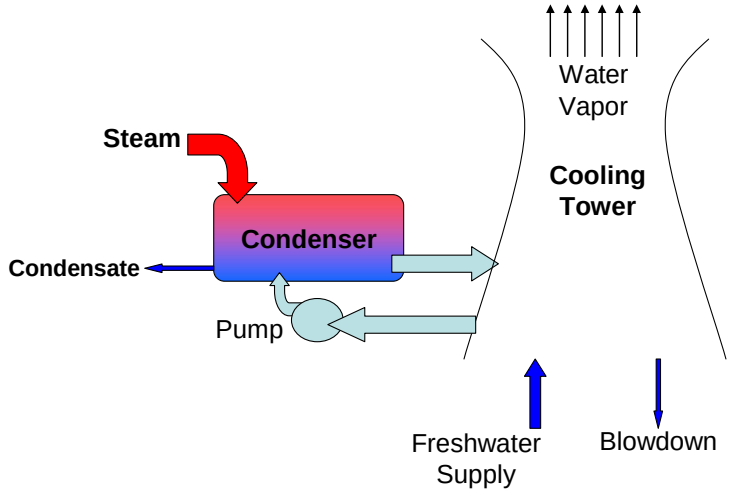
Source: USGS Circular 1268, March, 2004

Note: Hydropower uses are not included here!

Consumption versus Withdrawal

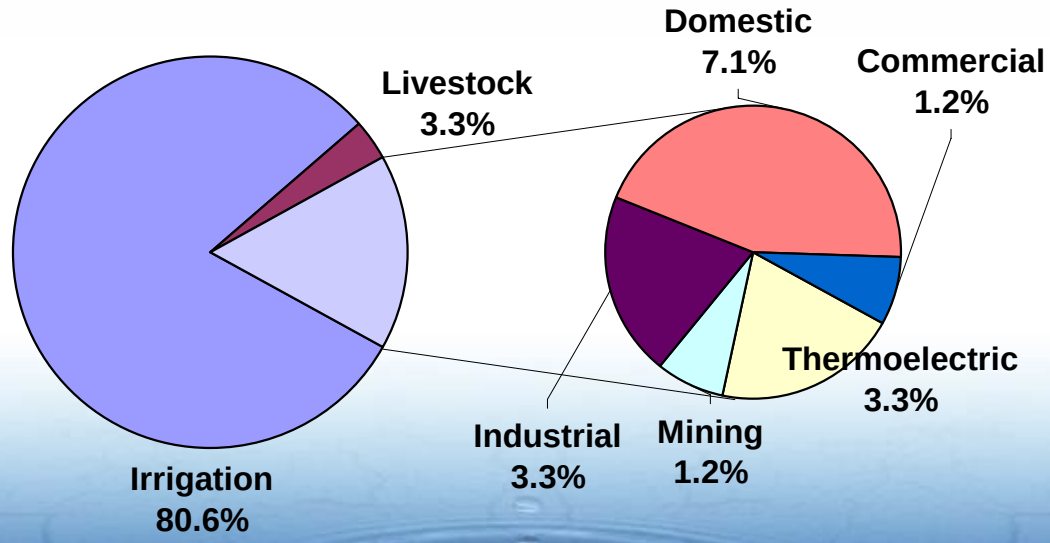


Constraint:
Thermal Discharge Limits



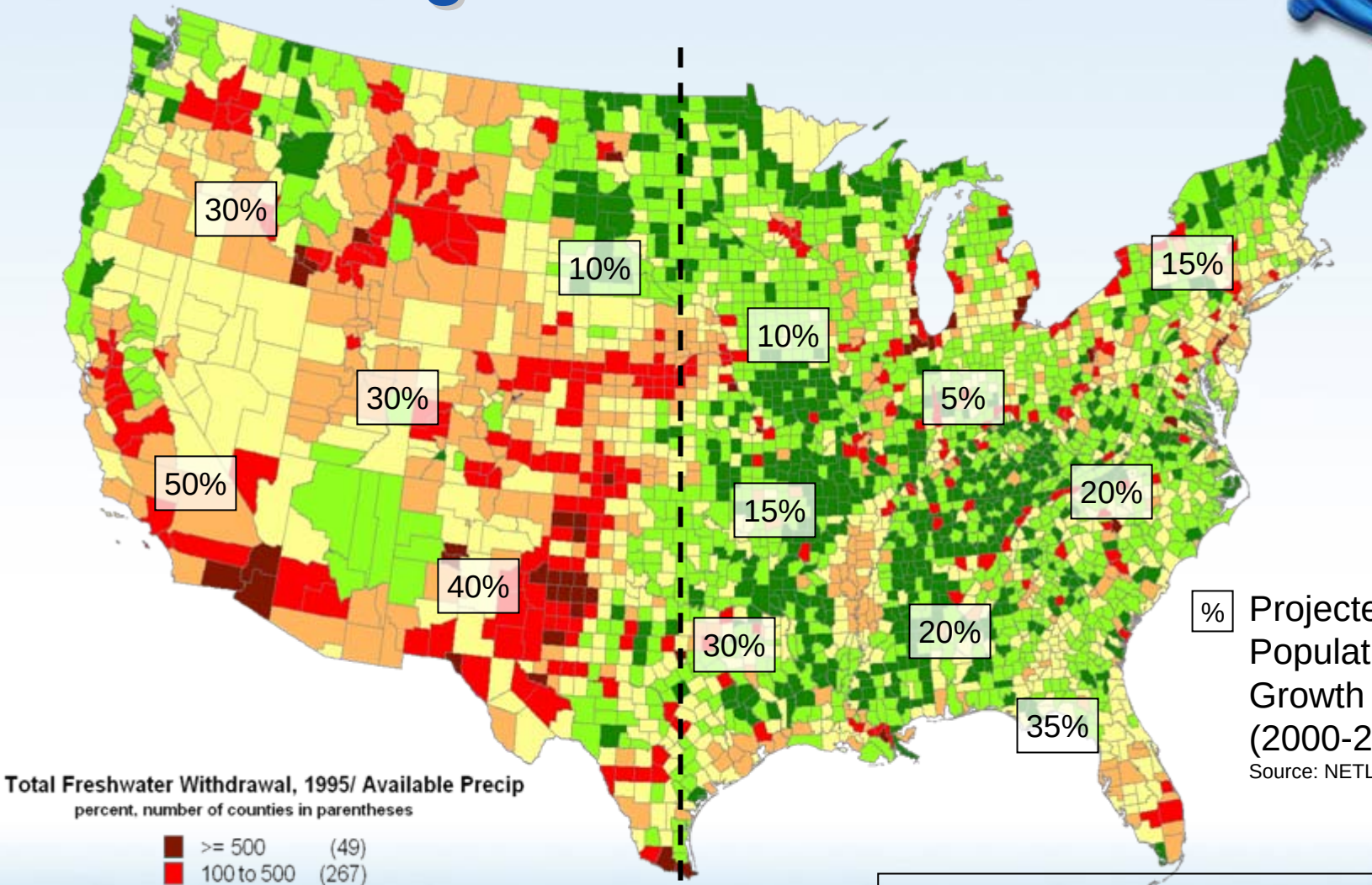
Constraint: Absolute Water Consumption

U.S. Freshwater Consumption, 100 Bgal/day



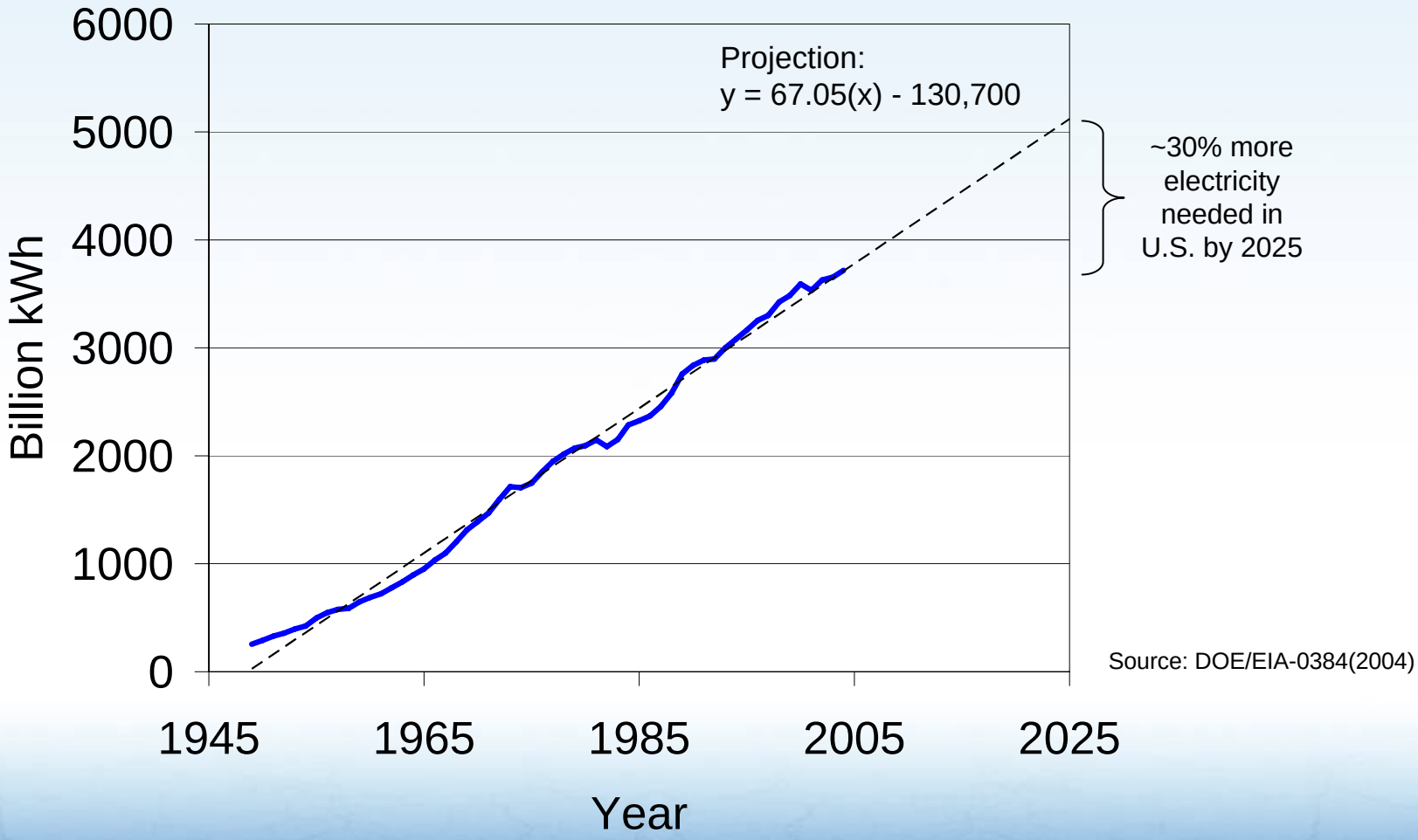
ENERGY and WATER

Water challenges are nationwide



ENERGY and WATER

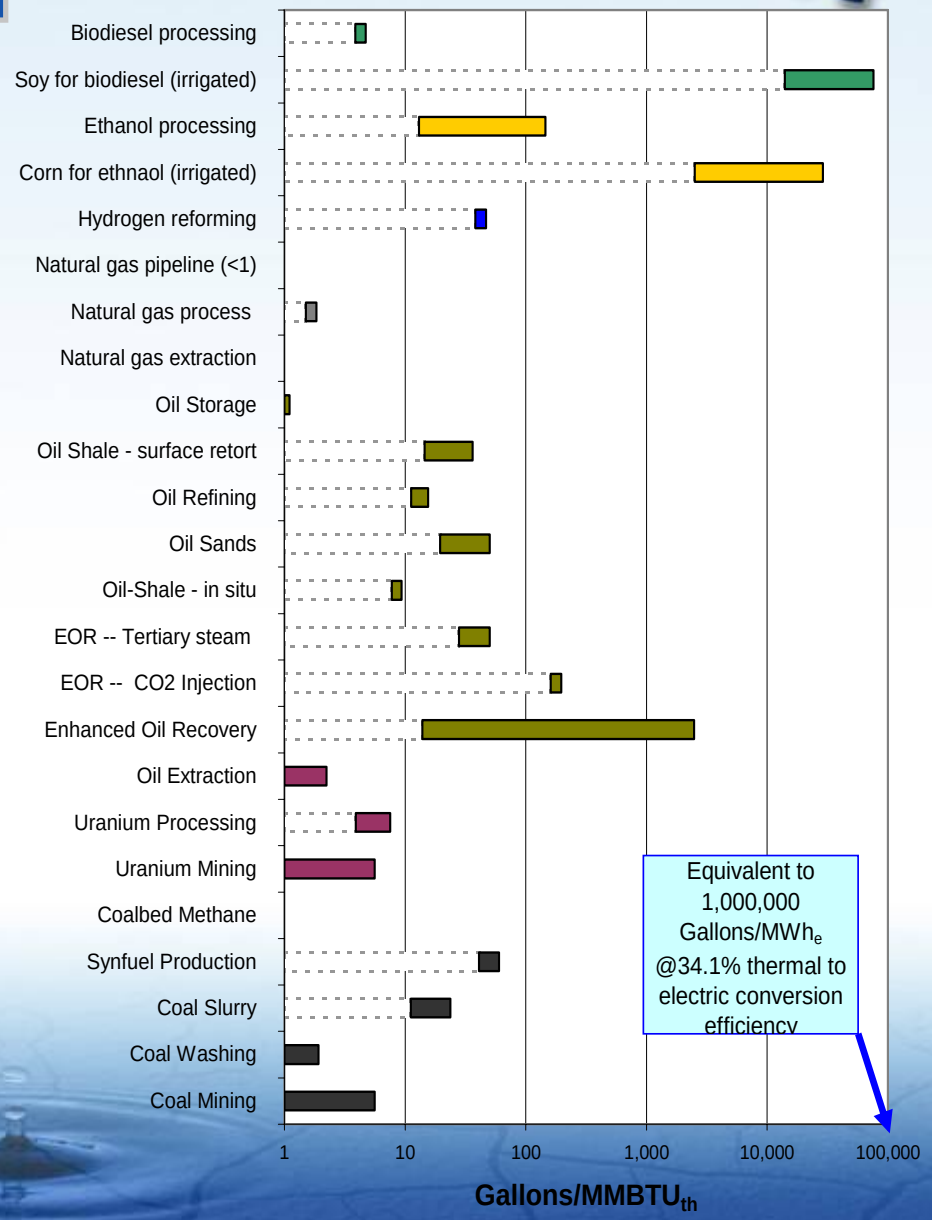
The U.S. will need 30% more electricity by 2025



Source: DOE/EIA-0384(2004)

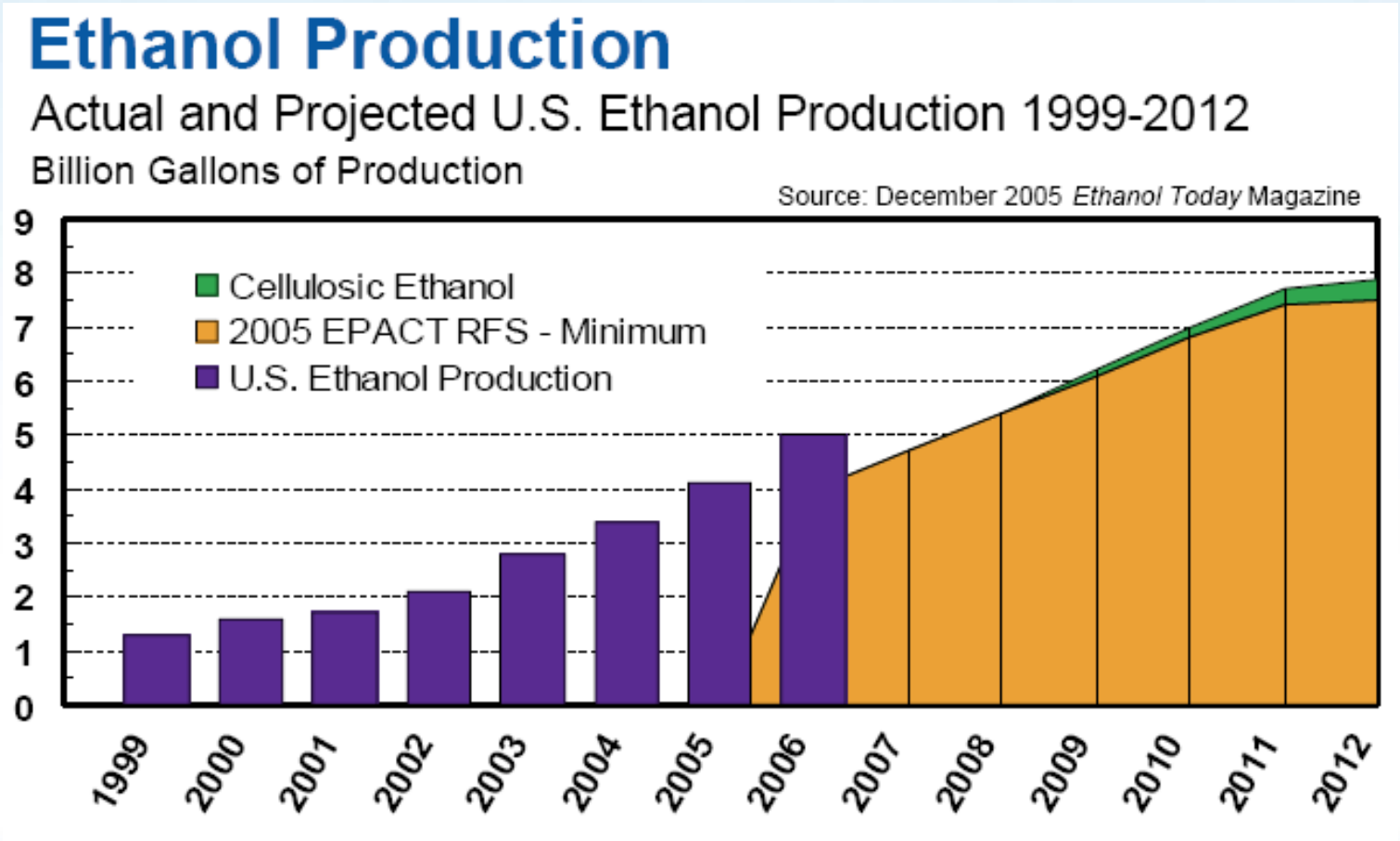
Future energy development will put new demands on water

- Many newer technologies will be more water intensive
- Biofuels and hydrogen economy would require significantly more water than fossil transportation fuels
- Constraints will grow for power plant siting because of water for cooling needs, advanced scrubbing, and CO_2 removal



ENERGY and WATER

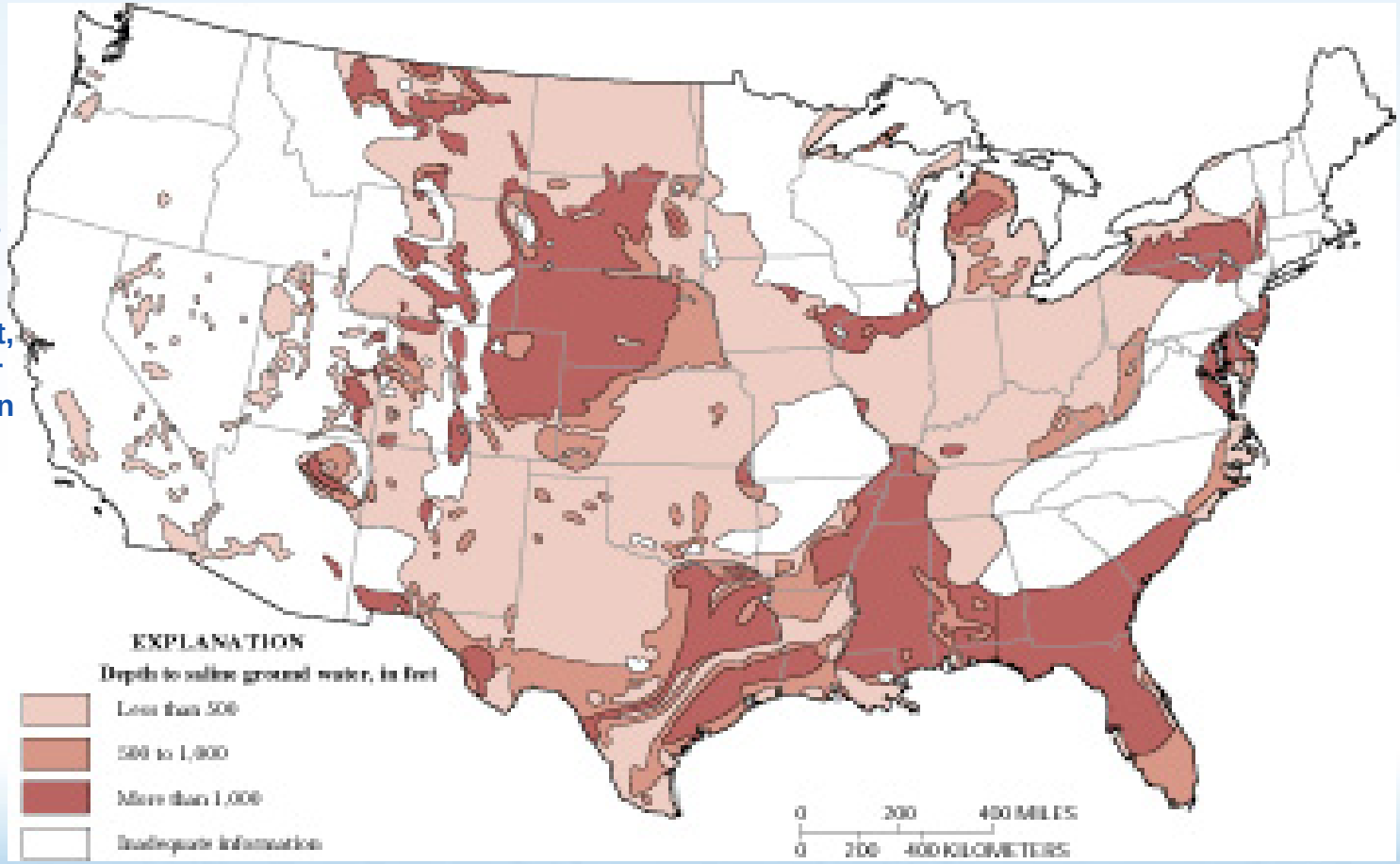
Example 1: Bioenergy Production May Increase Water Demand



- Total U.S. gasoline market ~140 billion gallons/yr
- 2-10 gallons of water used per gallon of ethanol refined
- Irrigated and non-irrigated ethanol have potential water concerns

Example 2: Saline water may be a required water resource in the near future

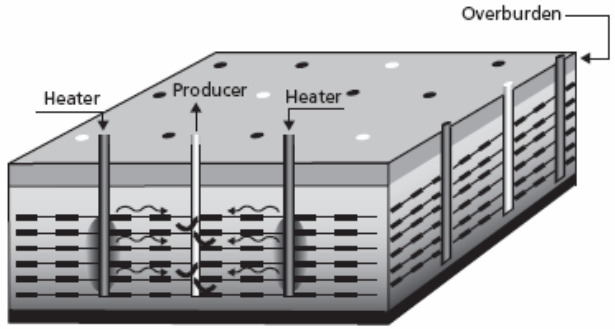
Saline aquifers in the continental U.S. The brown shading refers to the depth of the aquifer. With appropriate treatment, inland brackish water resources could be an important source of water for thermoelectric power plant cooling. (Data from Feth, 1965)



Example 3: Oil Shale development could impact water availability and quality

- Reserves are in areas of limited water resources
- In situ retort the emerging technology
- Water needed for retorting, steam flushing, and cooling
- Concerns over *in situ* migration of retort by-products and impact on ground water quality

Figure 3.2
The Shell In-Situ Conversion Process



SOURCE: Adapted from material provided by Shell Exploration and Production Company.
RAND MG414-3.2

Summary of Major National Needs and Issues Identified in Regional Workshops

1. Users desire integrated regional energy and water resource planning and decision support
2. Improved water supply and demand characterization/ monitoring
3. Improved water efficiency in thermoelectric power generation
4. Oil and gas produced water treatment to enable use rather than disposal
5. Energy efficiency for impaired water treatment and use
6. Water requirements for emerging/renewable energy resources will be an emerging area of research
7. Improved biofuels/biomass water use efficiency studies
8. Infrastructure changes for improved energy/water efficiency

Examples of Science and Technology Research Directions

- Improve sensors, collection frequency capability, and data base management systems to better assess and understand water availability and water use.
- Improve common decision support tools to enable collaboration among federal and state agencies and industry to improve integrated energy and water planning and management.
- Improve modeling of climate variability, meteorology, and hydrology to improve energy and water resources planning.
- Develop and accelerate the use of technologies that reduce fresh water consumption in alternate energy and bioenergy production and/or electric-power generation.
- Develop and introduce more water efficient energy technologies.
- Develop system analysis approaches to enable tradeoffs in infrastructure improvements; Examples: Co-location of energy and water facilities, or improved national transmission capabilities.
- Develop new materials and processes to treat and use nontraditional, brackish, or produced water in energy applications.

Energy-Water Science and Technology Roadmap Summary

- Results from all Workshops are presented at www.sandia.gov/energy-water

- Final report available September 2006